

Field of the invention

The present invention relates to the technology of electromagnetic separation of isotopes of chemical elements, particularly, to electromagnetic separation of
5 palladium isotopes.

The present invention can be most effectively used for industrial electromagnetic separation of stable palladium isotopes: palladium-102, palladium-104, palladium-105, palladium-106, palladium-108, palladium-110.

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Background of the invention

It is known a method of separation of isotopes of chemical elements used for industrial electromagnetic separation of isotopes providing heating of a crucible with
15 working substance and a gas-discharge chamber by thermal radiation of active resistance heaters, ionization of molecules of the working substance in the gas-discharge chamber, ions being extracted therefrom and formed in an ionic beam being separated and focused by magnetic field
20 according to the mass of isotopes and entrapped by receiving boxes (N.A. Kascheev, V.A. Dergatchev. "Electromagnetic separation of isotopes and isotopic analysis". Moscow, "Energoatomizdat", 1989).

Deficiency of the stated method is in that it has low efficiency of separation of the elements of platinum-palladium group.

The method described in the work (V.P. Botchin, B.E. Gavrilov, V.S. Zolotariov. "Isotopenpraxis" Heft 6 (1971) 232) is the closest on technical essence known method of industrial separation of palladium isotope in electromagnetic separator with use of a source of ions.

The method of separation of palladium isotopes described in the cited reference consists ^{of} is the following. Vapors of the working substance being formed during heating at temperature up to 1000°C in a crucible of the source in result of reaction of metal powder palladium and fluorine gas fed into the crucible through an inleakage system. The ions being formed in vapors of the working substance in the gaseous chamber of the source under action of electron emission of a hot cathode where they being drawn from and formed into ionic beam by electrodes of an ion-optical system. In process of passing through the pumped out separating chamber the ionic beams of palladium isotopes being separated in static magnetic field depending on mass of isotopes (Pd-102, Pd-104, Pd-105, Pd-106, Pd-108 and Pd-110), being focused by this field and entrapped by the relevant receiving boxes.

Drawback of the known method of palladium isotope separation in electromagnetic separator with use of a source of ions is in that the technical result is unsatisfactory because of low enrichment of entrapped isotopes due to dispersion of isotope beams on molecules of the residual gas, mainly fluorine, not reacted with metal palladium. Besides, presence of an additional parameter - pressure of fluorine - in the source crucible and in the separating chamber considerably complicates selection of focusing modes.

Other deficiencies of the known method are the following:

- necessity to use special constructional materials being corrosion-resistant to action of fluorine;
- special safety measures of protection which is a complicated problem in conditions of industrial manufacture.

The technical result of the present invention is in increasing of enrichment of separated palladium isotopes.

Summary of the invention

The stated object is achieved by that metal palladium being used as working substance. This working substance is not hygroscopic, feebly reacts with constructional materials and creates pressure vapors sufficient for

maintaining a steady arc discharge in temperature span from 1500 to 1700°C. The use of metal palladium (in form of powder, sponge, ingot etc.) as working substance allowed to obtain good focusing of ionic beams in manufacture conditions and to increase enrichment of separated palladium isotopes.

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exemplary
An ¹ ~~example~~ of embodiment of the method of palladium isotope separation in electromagnetic separator with use of a source of ions is presented below for explanation of the invention. One of separating chambers ^(at 2 in the Fig.) of the industrial electromagnetic separator "SU-20" - production of the industrial complex "Electrohimpribor", Russia - was used for the experiment. A weighed portion of spongy metal palladium was placed in a graphite crucible ⁴ combined with a gas-discharge chamber ⁵ of the ions ¹ source. After installation of the source and a six-boxes receiver ¹⁰ in the ^{inside of the walls 8 of the at 2 separating} separating chamber ~~of the separator~~ the chamber was pumped-out by vacuum pumps up to the pressure $(1-2) \cdot 10^{-3}$ Pa and the source was high-voltage trained of up to voltage 33-35 kV.

To obtain an electron beam in the gas-discharge chamber of the source the cathode block was applied voltages ensuring: filament current - 70-80 A, voltage between filament and hot cathode - 0.8-1.0 kV, emission current - 0.5-0.6 A. At current of arc discharge 0.5-1.5 A and

voltage of discharge 150-350 V ionization was carried out of the vapors of working substance formed at power of crucible heater of 2500 - 4000 W.

Formed palladium ions were drawn out through a slot of
5 the gas-discharge chamber with help of an ion-optical system and were shaped in an ionic beam which under action of accelerating voltage and static magnetic field of 2600 Oersted in the chamber was separated on six ionic beams of isotopes according to masses of the ions. These beams of
10 isotopes were focused by ^{the illustrated} magnetic field in a focal plane where inlets of ~~the receiver~~ ^{10 of a receiver} boxes were positioned.

After accumulation the receivers were taken out from the separating chamber, isotopes were removed by the method of anodic pickling from the boxes, obtained isotopic
15 enriched solution was analyzed on enrichment and processed to the finished product.

Following isotopes were obtained in the process of experimental-industrial separation on electromagnetic separator "SU-20":

- 20 - isotope Pd-102 with enrichment 85.4-92.9 % - 3 g;
 - isotope Pd-104 with enrichment 96.6-98.4 % - 34 g;
 - isotope Pd-105 with enrichment 98.4-99.1 % - 65 g;
 - isotope Pd-106 with enrichment 99.1-99.5 % - 82 g;
 - isotope Pd-108 with enrichment 99.4-99.6 % - 86 g;
25 - isotope Pd-110 with enrichment 99.2-99.5 % - 35 g.

The table represents basic parameters of the method of palladium isotope separation according to the claimed technical solution.

The table

No.	Basic parameters	Clamed technical solution
1.	Source	without inleakage system
2.	Working substance	metal Pd
3.	Arc discharge current, A	0.5-1.5
4.	Arc discharge voltage, V	150-350
5.	Power of crucible heater, W	2500-4000
6.	Pressure in the separating chamber, Pa	$(1-2) \cdot 10^{-3}$
7.	Pd load in crucible, g	15-20
8.	Mean operating time of the source, hours	25-30
9.	Ionic current on the receiver, mA	15-25

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The proposed method of palladium isotope separation in electromagnetic separator with use of a source of ions compared with the existing methods showed high performance in obtaining technical and economic result. Use in practice of the claimed technical solution enables to effectively use said method for industrial electromagnetic palladium

